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UNITED STATES DEPARTMENT OF AGRICULTURE  
Rural Electrification Administration

May 27, 1980

Supersedes 2/27/69

REA BULLETIN 345-21

SUBJECT: REA Specification for Polyethylene  
Raw Material

- I. Purpose: To announce a revision of REA Specification PE-200 for Polyethylene Raw Material.
- II. General: REA Specification PE-200 has been revised to reflect changes in raw material technology and testing techniques since the February 27, 1969, edition.

The newly revised specification becomes effective June 1, 1980. All polyethylene jacketing grade raw material shipped after that date to manufacturers of cables complying with REA specifications for such products, must comply with the revised REA Specification PE-200.

- III. Availability of Specification: Copies of the revised REA Specification PE-200 will be furnished by REA upon request. Questions concerning the revised specification may be referred to the Chief, Outside Plant Branch, Telecommunications Engineering and Standards Division, Rural Electrification Administration, U.S. Department of Agriculture, Washington, D. C. 20250, telephone number (202) 447-3827.

  
Assistant Administrator - Telephone

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SPECIFICATIONS:

Polyethylene Raw Material

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REA BULLETIN 345-21

PE-200

APRIL 1980

(Supersedes Issue  
dated January 1969)



SPECIFICATION FOR  
POLYETHYLENE RAW MATERIAL

REA SPECIFICATION FOR  
POLYETHYLENE RAW MATERIAL

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UNITED STATES DEPARTMENT OF AGRICULTURE  
Rural Electrification Administration  
Washington, D. C. 20250

REA SPECIFICATION FOR POLYETHYLENE RAW MATERIAL

1. SCOPE

1.1 This specification covers the requirements for low density, medium density and high density polyethylene raw material used as insulating and jacketing material on insulated wire and cable products.

1.2 All polyethylene raw material covered by this specification shall be polyolefin resin made from virgin material capable of meeting the properties outlined in this specification.

2. COLORS

2.1 Color concentrates may be added to natural resin by the wire and cable manufacturers. However, material so colored shall meet all the property requirements of this specification.

2.2 The following requirements are applicable to wire and cable manufacturers who add color concentrates to natural resin:

2.2.1 Color concentrates used for color compounding shall be listed and forwarded to REA for approval.

2.2.2 In lieu of any testing being required for color migration and color heat stability by the wire and cable manufacturers, certification from the producer of the color concentrates for these properties shall be acceptable. This certification shall be obtained from the producer of the color concentrates and shall be forwarded to REA by the wire and cable manufacturers.

2.3 If manufacturers of colored polyethylene raw material so desire, it will be permissible for them to obtain certification for color migration and color heat stability from their supplier of color concentrates and to forward this certification to the wire and cable manufacturers in lieu of their being required to test for these two properties.

3. CARBON BLACK

3.1 Wire and cable manufacturers will not be allowed to mix their own carbon black, either as a concentrate or starting from carbon black.



#### 4. MATERIAL CERTIFICATION

4.1 All polyethylene raw material, purchased by wire and cable manufacturers under this specification, shall be certified to comply with the appropriate requirements of this specification by the primary producer of the polyethylene raw material.

4.2 Although certification of compliance with this specification is acceptable from the producer of the polyethylene raw material, it is the primary responsibility of the wire and cable manufacturers to assure themselves that all requirements of this specification are met by performing quality control testing.

#### 5. LOW DENSITY POLYETHYLENE

##### 5.1 Inner Jacketing Grade Material

5.1.1 The desired material shall be Type I, Class A or C, Category 4 or 5, Grade E-4 polyolefin resin. Prior to extrusion, Class A or C material shall conform to the requirements of ASTM D1248-74, except as modified by this specification (see Appendix A for Class A material and Appendices B and E for Class C material).

##### 5.2 Jacketing Grade Material

5.2.1 The desired material shall be Type I, Class C, Category 4 or 5, Grade J-3 polyolefin resin. Prior to extrusion, the material shall conform to the requirements of ASTM D1248-74, except as modified by this specification (see Appendices B and E).

##### 5.3 Molding Procedure

5.3.1 When molded test specimens are required, they shall be prepared from compression molded sheets which have been molded according to procedure C of ASTM D1928-70 and which comply with the shrinkage requirement of paragraph 5.3.2.

##### 5.3.2 Checking the Sheet

5.3.2.1 Using a suitable micrometer, measure the thickness of the sheet at sufficient points to represent the entire area. If the thickness meets the limits for which the sheet is required, cut two specimens about 5 cm by 1 cm from different parts of the sheet so that the long axes of the specimens are approximately perpendicular. Measure the length of each specimen to 0.8 mm. Place the specimens in a shallow container containing a 0.3 cm layer of talc into an oven maintained at  $130^{\circ} \pm 2.5^{\circ}\text{C}$ . After 30 minutes, remove the container (with specimens) and allow the specimens to cool at room temperature. Remeasure the length of each. If the shrinkage exceeds 10 percent, discard the sheet and the specimens. If the shrinkage is 10 percent or less, compare the surface of the specimens with the surface of the sheet from which they were cut. If the surface of the specimens is essentially as smooth and free from irregularities



as the sheet, retain the sheet in a clean container (such as an envelope) and discard the two specimens.

### 5.3.3 Annealing Apparatus and Procedure

When annealed specimens are specified, they shall be annealed in accordance with procedure A, of ASTM D1928-70 except that stacking shall be in accordance with paragraph 5.3.3.1 and the annealing temperature shall be as specified in paragraph 5.3.3.2.

#### 5.3.3.1 Stacking

Stack the annealing units horizontally on a shelf or suitable support so as to permit free circulation of air on all sides of the stack as follows: Place a separator plate at the bottom. Center a follow-up plate plus a separator plate on each unit. Place the cover plate on top of the stack. To help avoid the formation of sink marks or bubbles in the test plaques it is permissible to apply a pressure of 14.0 MPa on the cover plate of the annealing stacks. (The follow-up plates intended to fit in the depression of the annealing unit to maintain good contact between the parting sheets and polyethylene during the expansion of melting and contraction of cooling.

#### 5.3.3.2 Annealing Temperature

Maintain the oven at  $145^{\circ} + 2^{\circ}\text{C}$  for 1 hour, then begin cooling as specified in procedure A of ASTM D1928-70.

### 5.4 Determination of Residual Strain

5.4.1.1 A 20 by 150 mm petri dish or equivalent.

5.4.1.2 A supply of talc, rubber grade or better.

5.4.1.3 A steel scale graduated to at least 0.8 mm.

#### 5.4.2 Procedure

5.4.2.1 Preheat the petri dish containing 3 to 6 mm of talc to  $145^{\circ} + 2^{\circ}\text{C}$  in an oven. Cut two specimens 1 cm by 4 cm  $\pm$  0.04 cm from different parts of the test sheet with their long axes perpendicular to each other. Place these specimens on the preheated talc, and maintain at  $145^{\circ} + 2^{\circ}\text{C}$  for 30 minutes, then remove the dish with the specimens, and allow to cool at room temperature.

5.4.2.2 Specimens which exhibit less than 10 percent shrinkage as measured by a scale readable to 0.8 mm and whose surfaces remain smooth and regular indicate a satisfactory test sheet. (Test sheets not meeting the 10 percent shrinkage value may be used if there is no adverse effect on the performance of the specimens under test.) The outside 6 mm of such sheets should be trimmed and discarded before the sheet is used.

## 6. MEDIUM DENSITY POLYETHYLENE JACKETING RAW MATERIAL REQUIREMENTS

6.1 The desired material shall be Type II, Class C, Category 4 or 5 polyolefin resin. Prior to extrusion, the material shall conform to the requirements of ASTM D1248-74, except as modified by this specification (see Appendix F).

### 6.2 Molding Procedure (I)

When molded test specimens are required, they shall be prepared from compression molded sheets. Except for the environmental stress crack resistance and low temperature elongation tests set forth in Appendix F, test sheets shall be molded and annealed according to the following procedure:

#### 6.2.1 Molding Procedure (I)

When molded test specimens are required they shall be prepared from compression molded sheets which have been molded according to procedure C of ASTM D1928-70.

#### 6.2.2 Annealing Apparatus and Procedure

When annealed specimens are specified they shall be prepared in accordance with procedure A of ASTM D1928-70 except that stacking shall be in accordance with paragraph 6.2.2.1 and the annealing and cooling rate shall be as specified in paragraphs 6.2.2.2 and 6.2.2.3, respectively.

##### 6.2.2.1 Stacking

Stack the annealing units horizontally on a shelf or suitable support so as to permit free circulation of air on all sides of the stack as follows: Place a separator plate at the bottom. Center a follow-up plate plus a separator plate on each unit. Place the cover plate on top of the stack. To help avoid the formation of sink marks or bubbles in the test plaques it is permissible to apply a pressure of 14.0 MPa to the cover plate of the annealing stacks. (The follow-up plates are intended to fit in the depression of the annealing unit to maintain good contact between the parting sheets and the polyethylene during the expansion of melting and contraction of cooling.)

##### 6.2.2.2 Annealing Temperature

The temperature of the oven shall be maintained at  $155^{\circ} \pm 5^{\circ}\text{C}$  for 1 hour.

##### 6.2.2.3 Cooling Rate

After the 1 hour period at  $155^{\circ} \pm 5^{\circ}\text{C}$ , the sheet shall be cooled at a rate of  $30^{\circ} \pm 1^{\circ}\text{C}$  per hour until a temperature of  $50^{\circ}\text{C}$  is obtained.

### 6.3 Determination of Residual Strain

6.3.1.1 A 20 by 150 mm petri dish or equivalent.

6.3.1.2 A supply of talc, rubber grade or better.

6.3.1.3 A steel scale graduated to at least 0.8 mm.

#### 6.3.2 Procedure

6.3.2.1 Preheat the petri dish containing 3 to 6 mm of talc to  $155^{\circ} \pm 5^{\circ}\text{C}$  in an oven. Cut two specimens 1 cm by 4 cm  $\pm 0.04$  cm from different parts of the test sheet with their long axes perpendicular to each other. Place these specimens on the preheated talc, and maintain at  $155^{\circ}\text{C}$  for 30 minutes, then remove the dish with the specimens, and allow to cool at room temperature.

6.3.2.2 Specimens which exhibit less than 10 percent shrinkage as measured by a scale readable to 0.8 mm and whose surfaces remain smooth and regular indicate a satisfactory test sheet. (Test sheets not meeting the 10 percent shrinkage value may be used if there is no adverse effect on the performance of the specimens under test). The outside 6 mm of such sheets should be trimmed and discarded before the sheet is used.

#### 6.4 Molding Procedure (II)

6.4.1 Where molded test specimens are required for environmental stress crack resistance and low temperature elongation tests as set forth in Appendix F, they shall be prepared from compression molded sheets which shall be molded in accordance with procedure B of ASTM D1928-70 except eliminate the one hour aging at  $150^{\circ}\text{C}$  between removal from the press and putting into cold water and annealed according to paragraph 6.5.

#### 6.5 Annealing

##### 6.5.1 Apparatus

6.5.1.1 Oven: A circulating air oven capable of maintaining a temperature of  $70^{\circ} \pm 2^{\circ}\text{C}$ .

6.5.1.2 Separator Plates: Smooth aluminum plates 20 by 23 by 0.2 cm.

6.5.1.3 Follow-up Plates: Smooth aluminum plates 14 by 17 by 0.2 cm.

##### 6.5.2 Annealing Procedure

6.5.2.1 This annealing conditioning shall be initiated within one hour after removal of the test sheet from the water cooling tank. Preheat the oven at  $70^{\circ} \pm 2^{\circ}\text{C}$ . Place the test sheet on a wide mesh wire shelf in the preheated oven. Hold the oven and test sheet at  $70^{\circ} \pm 2^{\circ}\text{C}$  for  $18.0 \pm 0.1$  hours; then remove the sheet from the oven and allow it to cool at room temperature on a cement asbestos slab.

#### 7. HIGH DENSITY POLYETHYLENE

##### 7.1 Insulating Grade Material

7.1.1 The desired material shall be Type III, Class A or B, Category 3, 4 or 5, Grade E-8 polyolefin resin. Prior to extrusion, the material shall conform



to the requirements of ASTM D1248-74 except as modified by this specification (see Appendix C).

## 7.2 Jacketing Raw Material

7.2.1 The material desired shall be either Type III, or IV, Class C, Category 4 or 5, Grade J-4 polyolefin resin. Prior to extrusion, the material shall conform to the requirements of ASTM D1248-74 except as modified by this specification (see Appendix D).

## 7.3 Molding Procedure (I)

7.3.1 Molded test specimens shall be prepared from compression molded test sheets which have been molded and annealed according to procedures outlined in paragraph 6.2.1, 6.2.2, and 6.3.

## 7.4 Molding Procedure (II)

7.4.1 When molded test specimens are required for environmental stress crack resistance and low temperature elongation tests as set forth in Appendix D, they shall be prepared from compression molded sheets which have molded and annealed according to procedures outlined in paragraphs 6.4.1 and 6.5.

# 8. TEST PROCEDURES FOR DETERMINING COLOR PROPERTIES

## 8.1 Color Migration

### 8.1.1 Applicability

8.1.1.1 The results of this test depend to a large extent upon the judgement and interpretation of the test operator and therefore represent only a general classification.

## 8.2 Apparatus

8.2.1 A box measuring 8 by 8 cm inside by approximately 15 cm high for storing the specimens under test and for keeping the load in position.

8.2.2 Metal cover and base plates: 8 by 8 cm of any convenient thickness.

8.2.3 A supply of 0.1 mm thick soft aluminum foil at least 8 cm wide.

8.2.4 A large mouth pint bottle with cap, containing sufficient lead shot or equivalent to give a total weight of 2 kgs including the cover plate.

### 8.3 Test Specimen and Interleaving Sheets

8.3.1 The test specimen consists of a press-polished 5 cm square of the colored plastic of any reasonable thickness 0.6 mm to 2 mm.

8.3.2 Prepare a white compound containing 2 percent anatase titanium dioxide. Make the base formulation identical with that of the colored compound, except for the colorant. Mold a sheet with a press-polished surface to any desirable thickness for example, 0.5 mm. Cut one 8 cm square interleaving sheet for each colored test specimen.

### 8.4 Test Conditions

8.4.1 Conduct the test at  $70^{\circ} \pm 2^{\circ}\text{C}$ . Results are relatively unaffected by humidity and preconditioning.

8.4.2 The test duration shall be 30 days.

### 8.5 Procedure

8.5.1 Place the metal baseplate in the bottom of the specimen holding box. Center each 5 cm colored specimen on a 8 cm white interleaving sheet and cover with a 8 cm square aluminum foil. Place this assembly on top of the baseplate, and stack additional assemblies on top. Place the metal cover plate over the last specimen assembly, and apply 2 kg load container. Store the entire assembly at  $70^{\circ} \pm 2^{\circ}\text{C}$ .

8.5.2 Remove the weight at the end of the specified test period, and examine the originally white interleaving sheet which has been in contact with the colored specimen.

8.5.2.1 Judge the intensity of migration on the following scale:

1. No perceptible bleeding.
2. Barely perceptible bleeding.
3. Slight, but very slight bleeding.
4. Distinct, but not strong bleeding.
5. Intense color bleeding.

### 8.6 Report

8.6.1 The report includes the following:

1. Complete sample identification.
2. Identity and concentration of colorant used.
3. Bleeding intensity observed.
4. Date of start of test.
5. Duration of test.
6. Test operator identification.

## 8.7 Color Heat Stability

### 8.7.1 Apparatus

8.7.1.1 Extrusion plastometer in accordance with ASTM Specification D1238-70.

### 8.7.2 Procedure

#### 8.7.2.1 Preparation of Sample

8.7.2.1.1 Charge the cylinder maintained at  $265^{\circ} \pm 3^{\circ}\text{C}$  with 8 grams of the colored compound. Place the piston, with a load of 325 grams, in position, and start the timer. After 5 minutes, cut off and discard the extruded portion. Make the cutoff flush with the bottom of the orifice. Make subsequent cutoffs in the same manner.

8.7.2.1.2 Immediately after cutting, force approximately 5 cm of extrudate through the plastometer in a maximum time of 15 seconds and cut off. Save this specimen for comparison with later samples.

8.7.2.1.3 After 30 minutes more, cut off and discard the extruded portion. Immediately after cutting, force approximately 5 cm of extrudate through the plastometer in a maximum time of 15 seconds and cut off. Save this specimen.

#### 8.7.2.2 Checking the Extrudates

8.7.2.2.1 Compare the original extrudate and the 30 minute specimen for color differences. Any marked differences in color shall be interpreted as failure.

TABLE I

TOLERANCE LIMITS								
		HUE		VALUE			CHROMA	
		H-	H+	V-	V+	C-	C+	
Color	Centroid							
Red	2.5R 4/12	1.25R 4/12	3.75R 4/12	2.5R 3.5/12	2.5R 4.5/12	2.5R 4/10	None	
Orange	2.5YR 6/14	1.25YR 6/14	3.75YR 6/14	2.5YR 5.5/14	2.5YR 6.5/14	2.5YR 6/12	None	
Brown	2.5YR 3.5/6	10R 3.5/6	5YR 3.5/6	2.5YR 3/6	2.5YR 4/6	2.5YR 3.5/4.5	2.5YR 3.5/7	
Yellow	5Y 8.5/12	2.5Y 8.5/12	7.5Y 8.5/12	5Y 8/12	None	5Y 8.5/10	None	
Green	2.5G 5/12	1.25G 5/12	3.75G 5/12	2.5G 4.5/12	2.5G 5.5/12	2.5G 5/9	None	
Blue	2.5PB 4/10	10B 4/10	5PB 4/10	2.5PB 3.5/10	2.5PB 4.5/10	2.5PB 4/9	None	
Violet	2.5P 4/10	1.25P 4/10	3.75P 4/10	2.5P 3.5/10	2.5P 4.5/10	2.5P 4/8	None	
White	N 9/	Value Tolerances: V- is N 8.75/; no V+ limit Chromaticity Tolerances: 5R 9/1 5G 9/0.5 5YR 9/1 5B 9/0.5 5Y 9/1 5P 9/0.5						
Slate	N 5/	Value Tolerances: V- is N 4.5; V+ is N 5.5/ Chromaticity Tolerances: 5R 5/0.5 5B 5/0.5 5Y 5/0.5 5P 5/0.5 5G 5/0.5						
Black	N 2/	Value Tolerances: No V- limit; V+ is N 2.3/ Chromaticity Tolerances: 5R 2/0.5 5B 2/0.5 5Y 2/0.5 5P 2/0.5 5G 2/0.5						



# APPENDIX A

## LOW DENSITY POLYETHYLENE INNER JACKETING RAW MATERIAL REQUIREMENTS

PROPERTY	TEST PROCEDURE	VALUE
Density	ASTM D-1505-75, with test specimens from pressing prepared according to Procedure C of ASTM D-1928-70.	Type I
Melt Index	ASTM D-1238-73, Procedure A, Condition E. This result shall be designated the initial melt index value of the resin. This melt index value (MIV) shall range within the following values.	MIV 0.00<0.40±0.05 0.40<1.00±0.10 1.00<2.00±0.25
Low Temperature Brittleness	ASTM D-746-73	-76°C 2/10 failures, maximum
Tensile Strength	ASTM D-638-77, Type IV specimen shall be 0.2 ± 0.01 cm in thickness. Speed D shall be used.	12.4 MPa minimum
Elongation	ASTM D-638-77, Type IV specimen shall be 0.2 ± 0.01 cm in thickness. Speed D shall be used.	500% minimum
Environmental Stress Crack Resistance	ASTM D-1693-75, Condition A. The test specimens shall be inspected for failure at the end of 48 hours and shall not exceed the specified value.	2/10 failures, maximum
Dielectric Constant	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dielectric constant.	2.30 maximum
Dissipation Factor	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dissipation factor.	0.0005 maximum

# APPENDIX B

## LOW DENSITY POLYETHYLENE JACKETING RAW MATERIAL REQUIREMENTS

PROPERTY	TEST PROCEDURE	VALUE
Density	ASTM D-1505-75. With test specimen from pressing prepared according to Procedure C of ASTM D-1928-70.	Type I
Melt Index	ASTM D-1238-73, Procedure A, Condition E. This result shall be designated the initial melt index value of the resin. This melt index value (MIV) shall range within the following values.	MIV 0.00<0.40±0.05 0.40<1.00±0.10 1.00<2.00±0.25
Low Temperature Brittleness	ASTM D-746-73	76°C
Tensile Strength	ASTM D-638-77, Type IV specimen shall be 0.2 ± 0.01 cm in thickness. Speed D shall be used.	4/10 failures, maximum 12.4 MPa minimum
Elongation	ASTM D-638-77, Type IV specimen shall be 0.2 ± 0.01 cm in thickness. Speed D shall be used.	500% minimum
Environmental Stress Crack Resistance	ASTM D-1693-75, Condition A, except the stress cracking reagent shall be a 10% solution (by volume) of 'Igepal' CO-630 and the conditioning requirement is waived. The specimens shall be prepared from molded plaques which have been annealed and slow cooled in accordance with paragraph 5.3.3. The test specimens shall be prepared and the test started within 24 hours after conditioning. The test specimens shall be inspected for failure at the end of 24 hours and shall not exceed the specified value.	2/10 failures, maximum
Dielectric Constant	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dielectric constant.	2.80 maximum
Dissipation Factor	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dissipation factor.	0.007 maximum
Carbon Concentration	ASTM D-1603-76. Channel black or furnace black shall be used.	2.60 ± 0.25%
Carbon Particle Size	Carbon black particle size shall be determined prior to dispersion.	Avg., not greater than 20 mu.
Carbon Black	Absorption Coefficient: ASTM D-3349-76	4000 minimum

# APPENDIX C

## HIGH DENSITY POLYETHYLENE INSULATING RAW MATERIAL REQUIREMENTS

PROPERTY	TEST PROCEDURE	VALUE
Density	ASTM D-1505-75, with test specimen from pressing prepared according to Procedure C of ASTM D-1928-70.	Type III
Melt Index	ASTM D-1238-73. Procedure A, Condition E. This result shall be designated the initial melt index (MIV) of the resin.	MIV 0.00<0.50 ± 25% 0.50<1.00 ± 18% 1.00<2.00 ± 15%
Low Temperature Brittleness <sup>(1)</sup>	ASTM D-746-73	-76°C 2/10 failures, maximum
Tensile Strength	ASTM D-638-77, Type IV specimen and shall be 0.20 ± 0.01 cm in thickness. The speed of jaw separation shall be 5 cm per minute. <sup>(1)</sup>	19.3 MPa minimum
Elongation	ASTM D-638-77, Type IV specimen and shall be 0.20 ± 0.01 cm in thickness. The speed of jaw separation shall be 5 cm per minute. <sup>(1)</sup>	400% minimum
Thermal Stress Crack Resistance	ASTM D-2951-71, except test specimens shall be prepared from molded sheets per paragraph 7.3.	No cracks within 96 hours.
Environmental Stress Crack Resistance	ASTM D-1693-75. Condition B, except that the molded test sheet shall be conditioned as outlined in paragraph 7.4 with the exception that the cooling rate shall be 5°C ± 0.5°C per hour. The test specimens shall be prepared and the test started within 24 hours after conditioning. The test specimens shall be inspected for failures at the end of 24 hours and shall not exceed the specified value. (Each specific polyethylene compound must qualify as having the inherent capability of passing this requirement when test specimens have been cooled at 30°C ± 1°C per hour.)	2/10 failures, maximum
Insulation Resistance	ASTM D-257-76 Figure 4 or 5A without guard electrodes. Mercury, foil or conducting paint electrodes may be used. Parallel plate 5 cm diameter polished stainless steel selfaligning electrodes under a pressure of 0.069 to 0.139 MPa also may be used. The same test specimens used for the dielectric constant determination shall be used for this test. Measure the insulation resistance after 4 minutes at 500 Vdc under test conditions at 23.0 ± 1°C temperature and 50 ± 2% relative humidity.	5 x 10 <sup>14</sup> ohms minimum



APPENDIX C (Cont'd)

PROPERTY	TEST PROCEDURE	VALUE
Color	Visual observation of Munsell Color Standards (See Table I for Munsell Color Notations.)	Munsell Color
Color Migration	See paragraph 8.1.	Intensity-2 maximum
Color Heat Stability	See paragraph 8.7.	No Marked Discoloration
Dielectric Constant	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dielectric constant.	Dielectric Constant Range 2.300-2.400. The total swing for any material supplier's compound (natural and/or colors) shall not exceed 0.040 within the above range.
Dissipation Factor	ASTM D-1531-75, Test frequencies of 100 kHz and 1 MHz $\pm$ 20% shall be used when measuring the dissipation factor.	0.0005 maximum
Volume Resistivity	ASTM D-257-76. Figure 4 or 5A without guard electrodes. Mercury, foil or conducting paint electrodes may be used. Parallel plate 5 cm diameter polished stainless steel selfaligning electrodes under a pressure of 0.069 to 0.139 MPa also may be used. The same test specimens used for the dielectric constant determination shall be used for this test. Measure the volume resistivity after 2 minutes at 100 to 500 volts dc under test conditions of $23^{\circ} \pm 1^{\circ}\text{C}$ temperature and $50 \pm 2\%$ relative humidity.	$1 \times 10^{15}$ ohm-cm minimum
Milling Stability	ASTM D-1248-74	After milling the test specimen meet the dielectric constant and dissipation factor req.
Water Immersion	Immerse the test specimens in distilled water at $23^{\circ} \pm 1^{\circ}\text{C}$ for 14 days. At the end of this period the test specimen is removed from the water, wiped dry and immediately tested for Dielectric Constant and Dissipation Factor.	After 14 immersion in water, the test specimen shall meet the Dielectric Constant and Dissipation Factor req.

(1) The annealing procedure outlined in paragraph 7.3 is not required for this test procedure.

# APPENDIX D

## HIGH DENSITY POLYETHYLENE JACKETING RAW MATERIAL REQUIREMENTS

PROPERTY	TEST PROCEDURE	VALUE
Density	ASTM D-1505-75, with test specimen from pressing prepared according to Procedure C of ASTM D-1928-70.	Type III or IV
Melt Index	ASTM D-1238-73, Procedure A, Condition E. This result shall be designated the initial melt index of the resin. This melt index (MIV) shall range within the following values.	MIV 0.00<0.40 ± 0.05 0.40<1.00 ± 0.10 1.00<2.00 ± 0.25
Low Temperature Brittleness	ASTM D-746-73 <sup>(1)</sup>	-76°C 2/10 failures, maximum
Tensile Strength	ASTM D-638-77. Type IV specimen and shall be 0.20 ± 0.01 cm in thickness. The speed of jaw separation shall be 5 cm per minute. (1)	19.3 MPa, minimum
Elongation	ASTM D-638-77. Type IV specimen and shall be 0.20 ± 0.01 cm in thickness. The speed of jaw separation shall be 5 cm per minute. (1)	400% minimum
Low Temperature Elongation	Same as for elongation test except that the test temperature shall be -17.8°C and the test specimens shall be prepared from molded plaques which have been prepared in accordance with paragraph 7.4. The test specimens shall be conditioned at the test temperature for at least 1 hour prior to testing.	175% minimum
Thermal Stress	ASTM D-2951-71, except that test specimens shall be prepared from molded sheets per paragraph 7.3.	No cracks within 96 hours.
Crack Resistance	ASTM D-1693-75, Condition B, except the stress cracking reagent shall be a 10% solution (by volume) of 'Igepal' CO-630. Test specimens shall be prepared from molded plaques in accordance with paragraph 7.4. The test specimens shall be prepared and the test started within 24 hours after conditioning. The test specimens shall be inspected for failures at the end of 24 hours.	0/10 failures Maximum
Dielectric Constant	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dielectric constant.	2.75 maximum
Dissipation Factor	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dissipation factor.	0.005 maximum
Carbon Concentration	ASTM D-1603-76. Channel black or furnace black shall be used.	2.60 ± 0.25%
Carbon Particle Size	Carbon black particle size shall be determined prior to dispersion.	Avg. not greater than 20 mu.
Carbon Black	Absorption Coefficient: ASTM D-3349-76.	4000 minimum

(1) The annealing procedure outlined in paragraph 7.3 is not required for this procedure.



# APPENDIX E

## LOW DENSITY ETHYLENE COPOLYMER JACKETING RAW MATERIAL REQUIREMENTS

PROPERTY	TEST PROCEDURE	VALUE
Density	ASTM D-1505-75, with test specimen from pressing prepared in accordance with Procedure C of ASTM D1928-70.	Type I
Melt Index	ASTM D-1238-73, Procedure A, Condition E. This result shall be designated the initial melt index of the resin. This melt index (MIV) shall range within the following values.	MIV 0.00<0.40 ± 0.05 0.40<1.00 ± 0.10 1.00<2.00 ± 0.25
Low Temperature Brittleness	ASTM D-746-73	4/10 failures maximum @ -76°C
Tensile Strength	ASTM D-638-77, Type IV specimen and shall be 0.2 ± 0.01 cm in thickness. Speed D shall be used.	12.4 MPa minimum
Elongation	ASTM D-638-77, Type IV specimen and shall be 0.20 ± 0.01 cm in thickness. Speed D shall be used.	500% minimum
Environmental Stress Crack Resistance	ASTM D-1693-75, Condition A, except the stress cracking reagent shall be a 10% solution (by volume) of 'Igepal' CO-630 and the conditioning requirement is waived. The specimens shall be prepared from molded plaques which have been annealed and slow cooled in accordance with paragraph 5.3.3. The test specimens shall be prepared and the test started within 24 hours after conditioning. The test specimens shall be inspected for failure at the end of 96 hours and shall not exceed the specified value.	0/10 failures, maximum
Dielectric Constant	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dielectric constant.	2.80 maximum
Carbon Concentration	ASTM D-1603-76. Channel black or furnace black shall be used.	2.60 ± 0.25%
Carbon Particle Size	Carbon black particle size shall be determined prior to dispersion.	Avg., not greater than 20 mu
Carbon Black	Absorption Coefficient: ASTM D-3349-76	4000 minimum

APPENDIX F

MEDIUM DENSITY POLYETHYLENE JACKETING RAW MATERIAL REQUIREMENTS

PROPERTY	TEST PROCEDURE	VALUE
Density	ASTM D-1505-75, with test specimens from pressing prepared according to Procedure C of ASTM D-1928-70.	Type II
Melt Index	ASTM D-1238-73, Procedure A, Condition E. This result shall be designated the initial melt index of the resin. This melt index (MIV) shall range within the following values.	MIV 0.00<0.40 ± 0.05 0.40<1.00 ± 0.10 1.00<2.00 ± 0.25
Low Temperature Brittleness	ASTM D-746-73 (1)	-76°C 0/10 failures maximum
Tensile Strength	ASTM D-638-77, Type IV specimen and shall be 0.2 ± 0.01 cm in thickness. The speed of jaw separation shall be 5 cm per minute. (1)	18.6 MPa minimum
Elongation	ASTM D-638-77, Type IV specimen and shall be 0.2 ± 0.01 cm in thickness. The speed of jaw separation shall be 5 cm per minute. (1)	400% minimum
Low Temperature Elongation	Same as for elongation test except that the test temperature shall be -17.8°C and test specimens shall be prepared from molded plaques which shall be prepared in accordance with paragraph 6.4. The test specimens have been conditioned at the test temperature for at least one hour prior to testing.	250% minimum
Thermal Stress Crack Resistance	ASTM D-2951-71, except that the test specimens shall be prepared from molded sheets per paragraphs 6.2.1, 6.2.2, and 6.3.	No cracks within 96 hours
Environmental Stress Crack Resistance	ASTM D-1693-75, Condition B, except the stress cracking reagent shall be a 10% solution (by volume) of 'Igepal' CO-630. Test specimens shall be prepared from molded plaques which have been prepared in accordance with paragraph 6.4. The test specimens shall be prepared and the test started within 24 hours after conditioning. The test specimens shall be inspected for failures at the end of 24 hours.	0/10 failures
Dielectric Constant	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dielectric constant.	2.75 maximum
Dissipation Factor	ASTM D-1531-75. Test frequencies of 100 kHz and 1 MHz plus or minus 20% shall be used when measuring the dissipation factor.	0.005 maximum
Carbon Concentration	ASTM D-1603-75. Channel black or furnace black shall be used.	2.60 ± 0.25%
Carbon Particle Size	Carbon black particle size shall be determined prior to dispersion.	Avg., not greater than 20 mu.
Carbon Black	Absorption Coefficient: ASTM D-3349-76.	4000 minimum

(1) The annealing procedure outlined in paragraph 6.2.2 is not required for this test procedure.